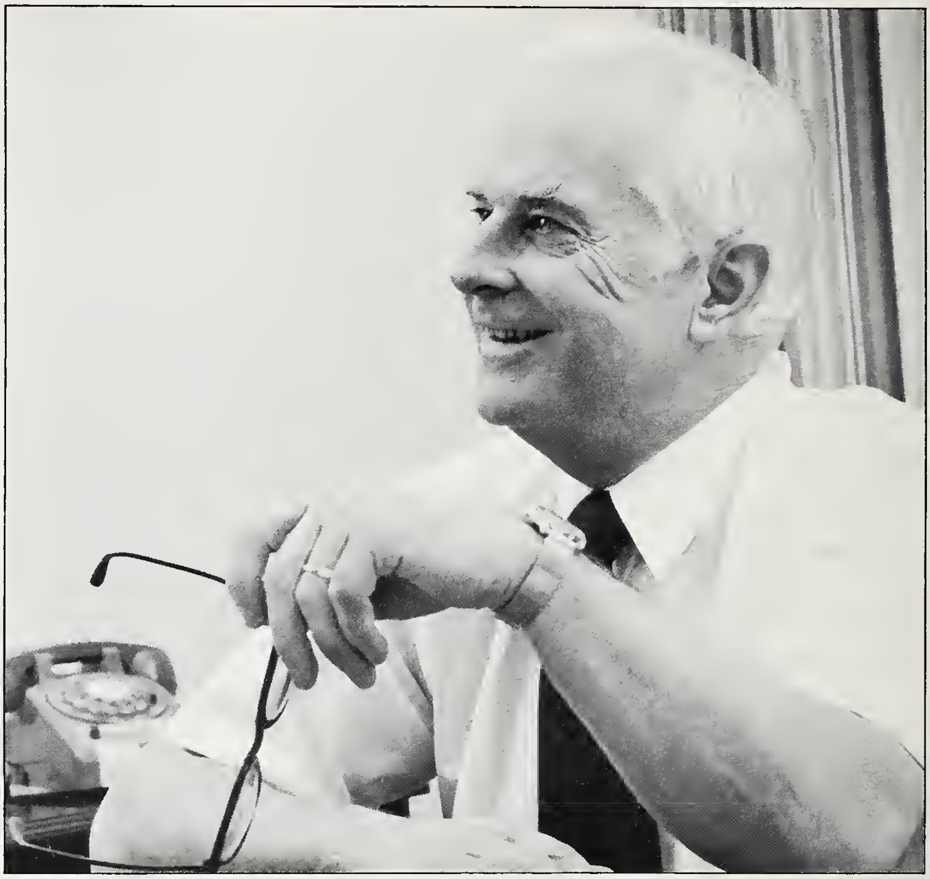
U.S. Department of Agriculture Science and Education Administration
March 1981

Agricultural Research

Terry B. Kinney—Answers Questions on Agricultural Research in the 1980's

Dr. Terry B. Kinney, administrator of Agricultural Research in the Science and Education Administration, recently invited questions from a number of SEA-AR scientists on the role of agricultural research over the next decade. Following are his answers to some of the questions:



Q: Russell Steere, Plant Virology Lab., Plant Protection Inst., Beltsville Md.: *What is being done to assure adequate funding of agricultural research now and in the future? Many important programs that USDA should tackle are not even being undertaken because of lack of funds. Often, when a research scientist retires or leaves, salary and support funds must be diverted just to cover expenses of the remaining research.*

A: Dr. Kinney: This problem has been with us some time, and we cannot expect it to go away. We have to deal with it as best we can. In the years ahead, we will have to work even harder in identifying problems, setting research priorities, defining the research to be done, and selecting the most appropriate method of conducting and supporting the research. When there is a vacancy we need to make a judgement as to whether we should fill the position or divert the resources to better support other research—that is simply good management.

There will be increasing emphasis on the quality of the research conducted and on the adequacy of quality control mechanisms. Like the rest of agriculture, the research sector, spurred by competition for resources, will have to increase efficiency and productivity. We must improve communications among all elements of the agricultural research community, and strengthen the partnerships in the agricultural research enterprise.

Q: Larry Cundiff, USMARC, Clay Center, Neb.: *What are the highest priority areas for agricultural research in the 1980's and how are they established?*

A: Dr. Kinney: Setting priorities is a complex task—one shared by the scientific community, including SEA scientists, Congress, and educational and user groups. Some of the considerations in formulating priorities are economic factors, specific needs of the general public, perceived or obvious threats to the environment and the health of the populace, present or impending shortages of energy and food, and national defense. As a result of this priority-setting process, for example, the Joint Council on Food and Agricultural Sciences has issued "Proposed Initiatives for the Food and Agricultural Sciences: 1981-86." Some of the specific areas of research recommended for increased emphasis in this report are:

Productivity

- Basic research to unlock more of nature's secrets relating to plants, animals, and pests. For example, gene manipulation and genetic engineering.
- Improved plant, animal, range, and forest integrated management systems. For example, development of multiple approaches to stress resistance and tolerance of plants to drought, saline waters, diseases, and insects.
- More efficient ways to process and market food, fiber, and wood.

Natural resources

- Soil conservation through improved irrigation and tillage practices.
- Water-use efficiency and water pollution prevention.
- Relationships of soil erosion and productivity.
- Reversing desertification of western ranges.
- Ways to increase commercial production from the Nation's forests while maintaining their environmental potential.
- Improvement of the land-water resource data bank.

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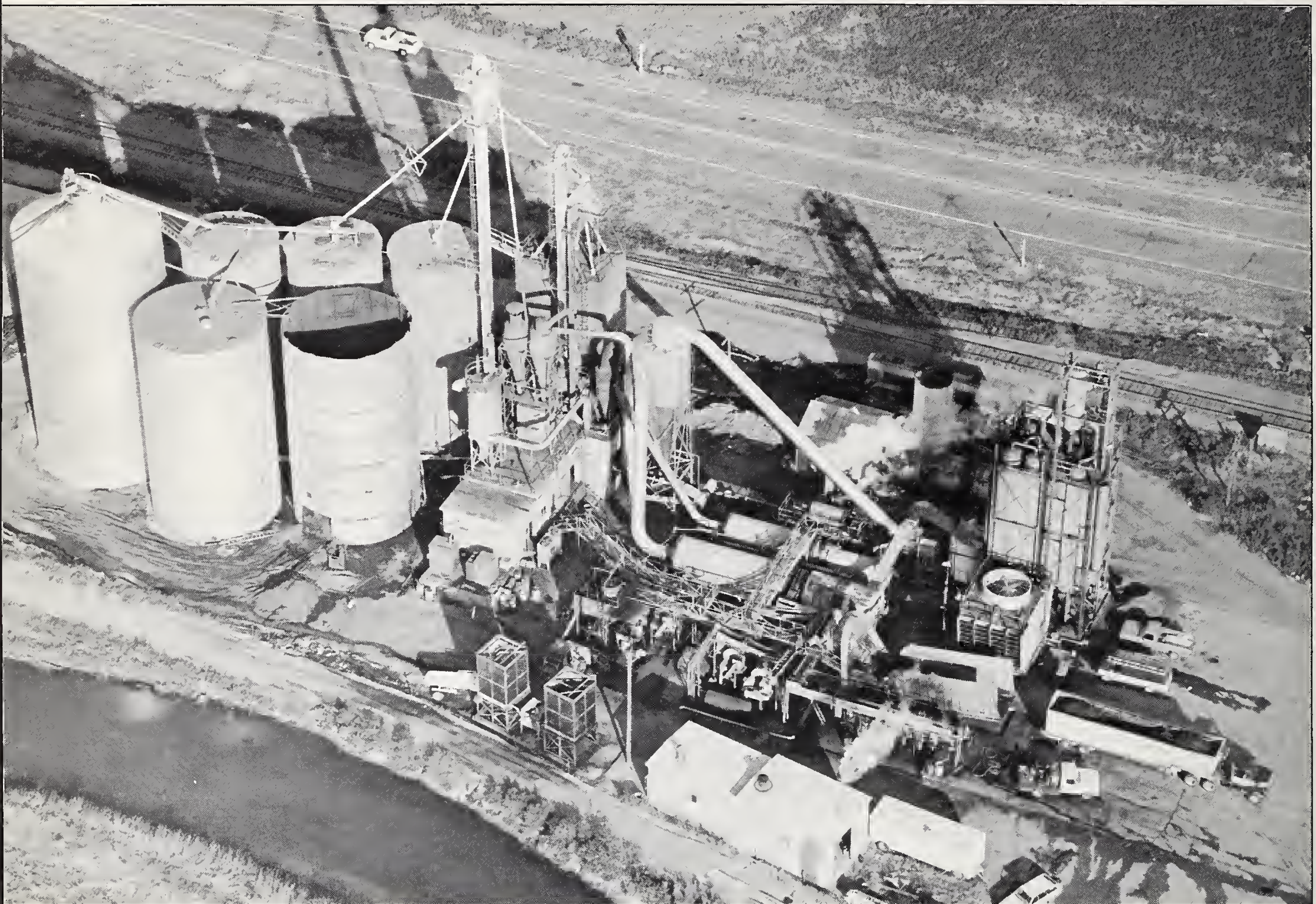
Cover: Key to energy savings in the PRO-XAN process is recycling hot gases normally left to escape in conventional alfalfa dehydrators. The PRO-XAN process sorts out the many valuable substances in alfalfa according to their most efficient feed use. Our article begins on page 4 (1080X1253-32A).



Above: Aerial view of the Valley Dehydrating Company plant near Sterling, Colo. Trucks unload alfalfa from nearby fields for dehydration. The plant can process up to 30 tons of alfalfa per hour (1080X1250-9).

Right: Alfalfa is "king" of all forages because of its high productivity, nutritive value, and low production costs. Earliest references to this plant date back to about 1300 B.C., although historians speculate that alfalfa was probably used to feed animals in eastern Mediterranean countries as early as 7000 to 4000 B.C. (1080X1252-23A).

Far right: George Kolher (left), prime researcher in PRO-XAN development, and Dale McDonald, Valley Dehydrating Company, survey an alfalfa field near the plant (1080X1253-25A).

PRO-XAN Production Goes Full Scale

A new energy-saving process for producing PRO-XAN—a high-protein, xanthophyll-rich alfalfa concentrate for poultry and swine—has been put into full-scale production by modifying a conventional dehydrator near Sterling, Colo. The PRO-XAN process, developed at the Western Regional Research Center, Berkeley, Calif., sorts out the many valuable substances in alfalfa according to their most efficient use.

The end products are PRO-XAN and a high-quality dehydrated alfalfa feed for beef cattle and sheep. PRO-XAN is also rich in xanthophyll, a natural leaf pigment needed in poultry rations to produce the desirable yellow color in broiler skins and yolks (see *Agricultural Research,* Sept. 1969).

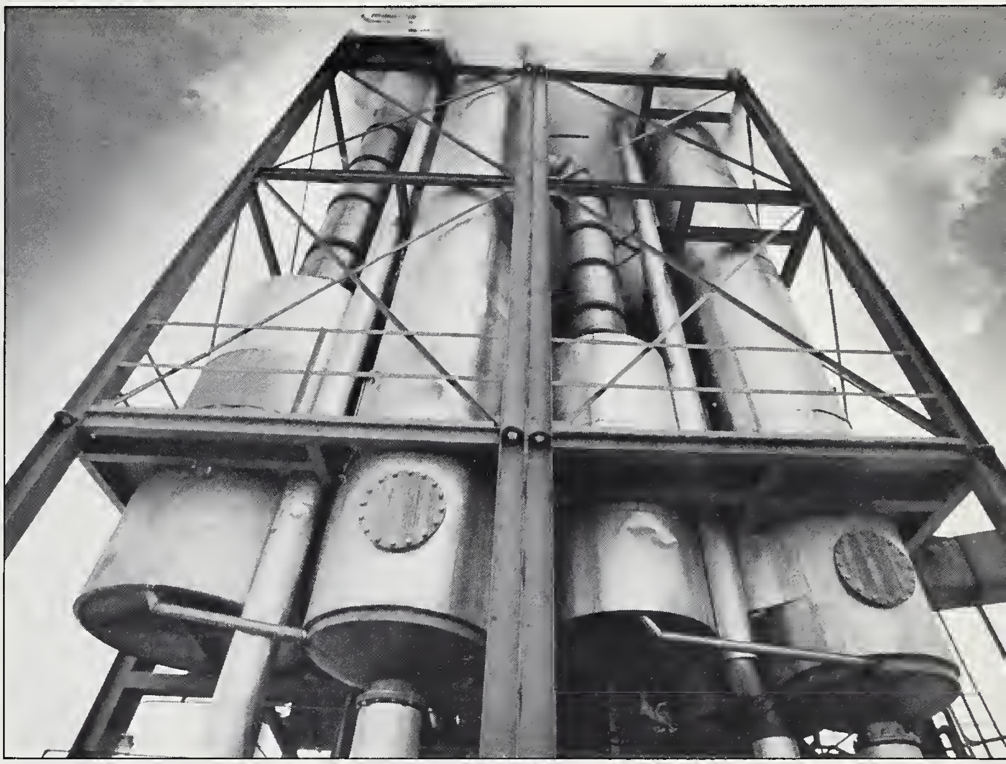
Recent refinements of the process, economic analyses, and partial funding from the U.S. Department of Energy (DOE) enabled Valley Dehydrating Company of Sterling to be the first in this country to convert a conventional dehydration plant to the new PRO-XAN process.

Data gathered on its full-scale operations are expected to indicate that energy savings, reduced air pollution, and production of more valuable products will justify conversion of other dehydrators to the PRO-XAN process.

"The energy savings alone could be 10 billion cubic feet of natural gas annually if all alfalfa dehydrators were converted to the PRO-XAN process," says SEA chemist George O. Kohler, leader of the group that developed the process.

The PRO-XAN process reduces energy consumption because it uses an efficient water removal process (pressing and vacuum evaporation) and utilizes waste heat by recycling hot stack gases through the evaporator instead of releasing them to the outside. Recycling not only uses the waste heat but also removes components that cause air pollution.

The juice left after protein and xanthophyll are extracted is converted into



Top: Vacuum evaporators use heat energy from dehydrator exhaust gases that normally escape into the atmosphere. Energy-saving devices such as this reduce energy consumption by 38 percent in the PRO-XAN process (1080X1253-6A).

Above: Truck loads of freshly cut alfalfa await grinding—the first step in PRO-XAN conversion process. Fresh alfalfa contains approximately 78 percent water (1080X1253-11A).

Side-by-side, rotary drums dry PRO-XAN (left), and another alfalfa product for cattle and sheep, (right). To save energy, pipes recycle heat normally lost in conventional dehydration plants (1080X1253-30A).

a syrup that contains 22 percent protein on a dry-weight basis and can be used directly as a feed supplement or added to the pressed alfalfa before dehydration.

The process does not greatly diminish the nutritional value of the alfalfa meal because only "surplus" protein, in the form of the fiber-free concentrate, is removed, leaving a dehydrated meal that contains enough protein to meet the requirements of beef cattle and sheep.

Alfalfa is an ideal raw material for protein production because its dried leaves contain 20 to 30 percent protein. Cereal grains such as wheat and oats contain only 7 to 12 percent. Alfalfa, a perennial plant, requires reseeding only every 4 to 10 years, and thrives from Mexico to Saskatchewan. It recovers within 28 days after cutting and provides between 2 and 10 cuttings per year, depending on locality.

Meanwhile, SEA researchers at the Western Regional Research Center are continuing their refinement of the PRO-XAN process to separate the protein one more step and obtain a food-grade white protein concentrate that could be used to increase the protein content of soups and breads.

Dr. Kohler's address is Western Regional Research Center, 800 Buchanan Street, Berkeley, CA 94710.—(By Dennis Senft, Oakland, Calif.)

Top: Peg Kattnig, Valley Dehydrating Company technician, analyzes for correct protein content in PRO-XAN (1080X1255-28).

Left: Cattle feedlots, similar to this one near Sterling, purchase much of the high-quality feed from the PRO-XAN process. (1080X1251-18A).

Far left: Kohler displays the pelletized "fruit" of SEA research—PRO-XAN (left), a high-protein, xanthophyll-rich feed for poultry and swine, and a dehydrated alfalfa feed (right), for cattle and sheep (1980X1254-19).

Stemming Stem Rust

Although many of us regard integrated pest management (IPM) as a modern concept, stem rust of wheat has been controlled in the United States since the early decades of this century through a successful program of integrated cultural practices. Because of its effectiveness, chemical controls have rarely been necessary.

John B. Rowell, recently retired director of the SEA Cereal Rust Laboratory, St. Paul, Minn., says that the rust control program provides one of the best examples of IPM to be found anywhere and is a classic example for younger programs to follow.

The program includes barberry eradication, quarantine restrictions, development of resistant wheat varieties, and disease monitoring. It grew out of the work of the late Elvin C. Stakman, plant pathologist first with the University of Minnesota and then with USDA. These practices have contributed significantly to the position the United States now holds as world leader in wheat production.

Before the rust control program, the major epidemics of wheat stem rust in this country were devastating—*1878,* 40 percent of the Nation's wheat crop destroyed; *1904,* a third of the spring wheat lost in Minnesota, North Dakota, and South Dakota; *1916*, about 38 percent of the U.S. crop destroyed. Stakman began his work after the 1904 epidemic, and the stem rust control program was initiated and developed from 1915 to 1920.

Stem rust, an old and widely known disease, is caused by a fungus which leads a complicated life. It requires living grain plants or wild grasses to duplicate itself and release infectious spores. This part of its life cycle is known as the red growth stage, named from the rusty color of its spores. In southern areas, stem rust overwinters in its red stage on living plant tissue

America's bountiful wheat harvest—stem rust control helps protect it. (19-11-3A).

and then spreads northward with new plant growth as weather conditions allow.

In more northern areas, as cold weather comes, the red growth stage changes to a black stage, capable of surviving winter on dead straw and stubble. The black stage is not capable of reproducing itself and spreading to new grain plants in the spring. However, it can infect nearby barberry plants in spring, undergoing sexual reproduction and producing new races that will infect nearby wheat. The barberry plant is literally a "rust nursery" that provides new virulent races capable of overcoming the resistance of existing wheat cultivars.

The barberry was introduced early into North America as an ornamental plant and spread widely as birds scattered its seeds. Farmers recognized the relationship of the barberry to the rapid spread of wheat rust, and in the late 1700's several states passed legislation aimed at controlling the spread of the plants. However, it took the 1916 rust epidemic to provide the thrust for a national program to eradicate the barberry.

The USDA eradication program, in cooperation with 13 states, began in 1918 under the direction of Stakman. Since then, the program has destroyed more than 500 million barberry plants in a 1-million-square-mile area, nearly eliminating susceptible plants from the major wheat-growing areas of the country. Because of this large-scale eradication program, rust must now work its way up from its overwintering quarters in central or south Texas.

In addition to the eradication program, a quarantine program was begun to prohibit interstate movement of susceptible barberry plants and seeds. The program includes inspection of nurseries selling barberries.

Stakman and his coworkers discovered in 1916 that many different races of the rust fungus caused wheat stem rust and that the racial composition of the fungus varied from year to year. This explained why a wheat selection resistant one year became susceptible the next.

Stakman began an annual rust survey to monitor the disease, collect samples, and identify the rust races. He then evaluated the various sources of rust resistance in wheat by exposing them to all the prevalent races. (An article on the annual rust survey follows in this issue of *Agricultural Research.*)

Breeding for rust resistance then became an effective element of the program. The early breeding program developed wheat lines with specific resistance to a specific race of rust. Unfortunately, this tactic provided only short-term benefits. The rusts frustrated the breeders by undergoing a period of natural selection in which only those rusts survived that could overcome the specific resistance bred into the wheats.

Ceres, the first variety carrying effective resistance to stem rust, was widely grown until 1935 when race 56 of stem rust caused a severe epidemic, producing wheat losses estimated at 118 million bushels.

In 1953 and 1954, another epidemic occurred, this time with race 15B. Fortunately, the laboratory pathologists had identified the wheat genes carrying resistance to race 15B in 1940 during the annual rust survey and were able to release new varieties quickly enough to save the durum wheat industry.

The solution to these recurring epidemics lay in developing wheats carrying combinations of genes resistant to many races. Toward this end, the International Wheat Rust Nursery Progrm was started in 1950 with plantings in 36 countries. These nurseries evaluate the resistance of wheats to local rusts.

"The cooperative nursery program has shown us," says Rowell, "that there are rusts somewhere in the world capable of infecting every modern wheat variety. There is no completely effective source of simple resistance to wheat stem rust."

Over the last 20 years, the Cereal Rust Laboratory staff has identified and developed rust-resistant germplasm for more than 100 wheat varieties. Each year the scientists evaluate 25,000 to 40,000 wheat lines in their search for new genetic rust resistance.

The value of this program was amply demonstrated in 1972 when weather conditions and rust sources were favorable for an epidemic and the research plots of susceptible varieties showed severe damage early and throughout the growing season. Because the commercial wheat varieties being grown were bred for early maturity and rust resistance, damage was limited to no more than one-half of 1 percent of the crop.

According to Rowell, if research work on developing resistance wheat varieties stopped tomorrow, serious rust epidemics would begin again within 5 to 10 years.—(By Ray Pierce, SEA, Peoria, Ill.)

Monitoring Stem Rust: A Key to Control

The SEA Cereal Rust Laboratory at St. Paul, Minn., is responsible for continually monitoring the stem rust population in the United States to determine whether new and threatening races have appeared. The laboratory is a central nerve center for alerting cooperators about significant shifts in the rust situation.

"The annual monitoring program is a key to our rust control system. It shows what rust races are active so we can judge how effective the resistance is in commercial cultivars. Then, we will have time to develop resistant plant materials to be used by breeders to fight back quickly," says John B. Rowell, recently retired laboratory director. "In the monitoring program, our pathologists know what to look for and where to look for it."

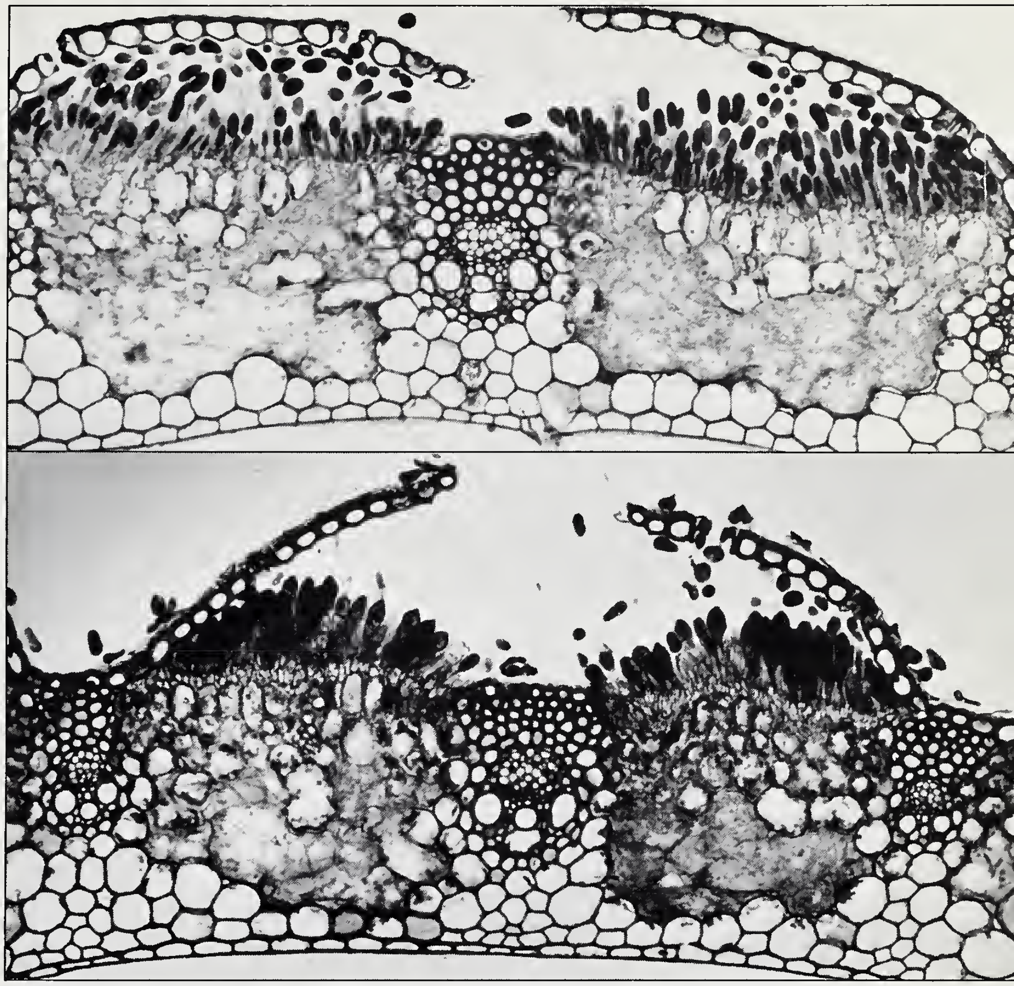
Alan P. Roelfs, research plant pathologist, and David L. Long, plant pathologist, both stationed at the Rust Laboratory, spend much of the spring and summer surveying rust populations in the United States. They begin in south Texas about the first of April and continue monitoring rust conditions as they move northward throughout the growing season. Roelfs and Long usually make five trips and are in North Dakota and Montana by late July.

In addition to the Great Plains Wheat Belt, the pathologists survey the southeastern wheat area from Florida westward to Louisiana. Each researcher covers about 2,000 to 4,000 miles by car each trip. Following a predetermined route through the wheat area, they stop about every 20 miles to check a field.

The scientists also work with many university cooperators who maintain "trap" plots, (usually 6 feet wide by 8 to 200 feet long) of susceptible wheats so they can easily detect any rust organisms present in the area. These plots are important to the survey since nearly all commercially grown wheats are now resistant varieties, making it difficult to find rust in farm fields, Roelfs says.

The pathologists collect leaf and stem samples and take them back to St. Paul, where they are cultured. The spores from the cultures are applied to small grains under controlled conditions. The researchers can then identify the rusts, evaluate their virulence, look for new races, and try to predict what will happen next.

The Rust Laboratory staff tests 1,500 to 2,000 rust samples each season; about half of these are taken during the survey trips. Many other samples come from cooperators' research plots in Mexico, Canada, and U.S. locations, as well as from the St. Paul facility.—(By Ray Pierce, SEA, Peoria, Ill.)



Top: Cross-section of wheat leaf shows anatomy of the red stage of stem rust infection. Fungal invasion of the leaf can be seen in gray areas with filamentous threads (hyphae). Near the top surface of the leaf, spore-bearing hyphae are releasing single-celled urediospores (the dark oval-shaped cells) which have ruptured the epidermis (covering layer of cells) of the leaf. The urediospores will become windborne and infect other wheat plants.

Above: Cross-section of wheat leaf shows the black stage of stem rust disease. At this stage of infection, the fungus produces two-celled teliospores—the dark elongated cells near the top of the leaf. Teliospores can survive cold temperatures and thus overwinter on dead wheat stubble. In the spring teliospores will produce basidiospores which can invade nearby barberry bushes. It is in the barberry that sexual reproduction occurs and produces aeciospores to be carried by the wind to infect wheat and grasses and to reestablish the red stage of the disease.

National Herb Garden— Historic *and* Trendy

A circular brick path leads Holly Harmar Shimizu, curator, and visitors into the Oriental Specialty Garden where they view boxwood and rice (foreground). During the growing season, The National Herb Garden offers 1½-hour lecture tours to the general public (980X1164-13).

Many recipes, in cookbooks, magazines and newspapers, now call for herbs that were neglected for years. Herb shops are not uncommon. Their mingled fragrances tempt even the timid customer to try herbal teas, soaps, and cosmetics.

The National Herb Garden reflects the popularity of herbs, but it is not just a trendy planting. This special garden serves as a permanent resource for all of us who are interested in the history of herbs or want to grow our own. Visit The National Herb Garden—find out why some gardeners grow their own herbs. Be forewarned—some visitors instantly become devotees.

The Garden is the newest major attraction at The National Arboretum, a 444-acre SEA facility in northeastern Washington, D.C. A joint project of The Herb Society of America and the Arboretum, The National Herb Garden was dedicated June 12, 1980. The Herb Society contributed $400,000 for the project and Congress appropriated $200,000.

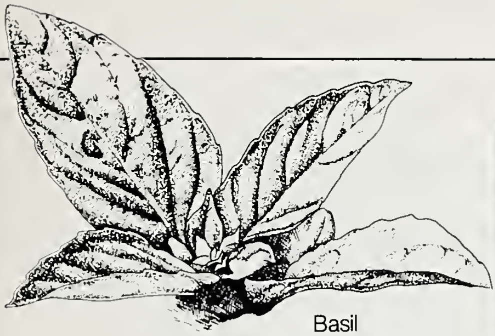
"1981 is our first full season, and the first opportunity we will have to fully demonstrate the fascination, pleasure, and rewards of herb gardening," says curator Holly Harmar Shimizu. "Last year we devoted so much time and effort to establishing the Garden, that many of the plantings were behind schedule and then suffered from one of the hottest Washington summers in memory."

Three Gardens in One

The National Herb Garden is really three gardens in one. In herbalist phraseology, it consists of three "rooms," each containing a major garden. Plant material masses, changes in elevation, and treillage (lattice-work) separate, yet integrate, the rooms: a knot garden, a historic rose garden, and speciality gardens.

Knot Garden

Three interlacing plant chains—each of a different species—weave through the knot garden. Openings created by



Basil

these chains of Japanese holly, dwarf blue cypress, and dwarf arborvitae are filled with crushed brick.

The Garden's intricate and formal design is simple compared to the original knot gardens of Renaissance France and Italy. Much detail in the Renaissance designs, in turn, was borrowed from Greek and Roman embroidery pattern books.

When garden designs were taken from embroidery patterns, gardeners developed a special vocabulary to indicate design features. This vocabulary included such words as tendril, beads, plums, interlacing, and wreaths. The French name for these gardens was "parterres de broiderie," and in England the patterns were called "knots." Spaces between the chains usually were filled with nonplant materials including colored soil, crumbled brick, iron filings, or colored pebbles.

Historic Rose Garden

Roses are prominently mentioned in every phase of the long history of the culture and use of herbs. Literature of the Roman Empire contains many references to roses and the cultivation of rose gardens. Both Roman and Greek writers described the therapeutic value of rose leaves and petals. And ancient Egyptians knew how to extract scented oil from rose petals. Dried rose petals have been used as room fresheners for centuries.

"The prominent position of roses in herb gardening was established by wild roses, long before breeders started developing the hybrids familiar to modern gardeners," says Shimizu. These wild roses are usually referred to as "old" or historic roses. These are the fragrant roses traditionally included in formal herb gardens. Unfortunately, however, many historic roses

Above: Ah—so sweet it is! The "old" roses in the Historic Rose Garden prove too tempting as another visitor succumbs to their fragile fragrance. An extract from the damask breed of these roses is still used in making perfumes (980X1166-33).

Left: Edible crysanthemums? Visitors closely inspect the leaves of this plant that the Japanese use as flavoring in "clear soup" (980X1165-3).

A tantalizing whiff of fresh mint enthralls this visitor to the Industrial Specialty Garden (980X1163-23).

Thyme

The freshly manicured grounds of The National Herb Garden are the handiwork and pride of youth participating in the Young Adult Conservation Corps. These young people water rosemary and clip basil in the Culinary Specialty Garden (980C1164-17).

have not been perpetuated, and some of those that were saved are not readily available. About half of the current rose collection at The National Herb Garden was brought over from Europe.

Specialty Garden

The 10 separate gardens in the specialty garden are arranged in an oval. Although they vary somewhat in size, most are about 40 feet long and 25 feet wide. Each of these gardens reflects a theme, showing the historic importance of the plants and their cultural, pharmaceutical, commercial, and culinary uses:

Dioscorides—This garden includes some of the plants used and described by Dioscorides, and outstanding Greek physician during the first century A.D. His book, *De Materia Medica,* was the standard work on botany and the therapeutic uses of plants and plant parts for 1,500 years.

Early American—This garden includes orris, bee balm, and other plants used by the pioneers. Many settlers brought medicinal or other herbal plants from their homeland, and also used native plants.

Dye—Even today, when a wide choice of synthetic dyes is available, many fabric workers prefer dyes derived from plants. These include indigo, goldenrod, and yarrow.

American Indian—American Indians used herbs as a source of medicines, dyes, poisons, foods, and materials for their many crafts. This collection—used by Indians of Eastern North America—includes wild tobacco, black cohosh, and wild strawberry.

Modern Botanicals—This garden portrays today's medicinal herbs. Included, for example, is Digitalis purpurea, the foxglove plant that furnishes the digitalis used for treating heart ailments.

Culinary—Here, visitors probably will find more familiar plants than in any other specialty garden. Included are garlic, thyme, dill, savory, parsley, and rosemary.

Industry—This garden displays economically important crops such as cotton, rice, jute, flax, rape, and hemp.

Fragrance—Many home gardens or window boxes include some of these planets: lavender, mint, rosemary and scented geranium.

Oriental—Oriental people have cultured and used herbs for several thousand years, and herbalists in other parts of the world have much to learn from them. Plants in this garden—including coltsfoot, camellia, and edible crysanthemum—come from China, Japan, and Korea.

Beverage—Visitors who think that tea is made from only one plant species may be surprised at the wide range of plants and plant parts that are brewed for drinking. Many cultures have their own favorite herbal teas.

The National Arboretum, including The National Herb Garden, is located at 24th and R Streets, N.E., Washington, D.C., and is open to the public every day of the year except Christmas. Visiting hours are 8:00 a.m. to 5:00 p.m. Monday through Friday and 10:00 a.m. to 5:00 p.m. Saturday and Sunday.—(By Andy Feeney, SEA Information, Washington, D.C.)

Bacteria Sediment in Streambeds

Splashing barefoot through an inviting mountain or rangeland stream may be stirring up trouble for downstream lakes and reservoirs used for drinking water and recreation. Many streambeds often harbor great concentrations of *Escherichia coli (E. coli)*, the sometimes pathogenic bacteria found in all warm-blooded animal feces.

SEA geologist Gordon R. Stephenson, at Boise, Idaho, and microbiologist Robert C. Rychert, at Boise State University, found that bottom sediments contained 2 to 760 times greater *E. coli* concentrations than did overlying stream waters.

These two researchers are studying streambed sediments in hopes of clearing up some mysteries. For example, if grazing livestock are the source of bacterial pollution in streams, then why do bacterial counts of many streams remain relatively high long after these livestock are removed from the area? Nor has anyone explained fully why bacterial counts shoot up sharply following runoff from rainstorms and melting snow.

Stephenson and Rychert offer an answer—*E. coli* readily attach themselves to sediment particles and streambed sediments are a good medium for bacterial growth. "Any disturbance, even a minor one such as the increased flow velocity from snowmelt runoff, stirs up sediment and resuspends *E. coli* or other bacteria in the water. This increases pollution and lowers water quality," says Stephenson.

Their tests indicate, however, that the organic composition at the sediment-water interface influences the survival and multiplication of bacteria.

While studying stream bottom sediments as potential bacterial pollution sources, Stephenson and Rychert came upon what they call "atypical" *E. coli*. In the standard test for identifying fecal bacteria, colonies of "typical" *E. coli* look blue when stained. The atypical *E. coli* colonies reported by Stephenson and Rychert stained pale yellow.

Livestock manure may be the source of *Escherichia-coli* concentrations in rangeland streambeds. If streambed sediment is stirred, this sometimes pathogenic bacteria could travel downstream, contaminating waters used for human consumption.

The number of atypical *E. coli* exceeded the number of typical *E. coli* in some of the streams studied, although they were generally not as prevalent. These two researchers are now starting a 1-year study of four streams to determine the frequency of atypical occurrence.

Stephenson warns, "Failure to take into consideration the bacteria in streambed sediments and the number of atypical *E. coli* present, could result in stream water quality evaluations that are misleading."

Stephenson works at the Northwest Watershed Research Center, Patti Plaza, Suite 116, 1175 South Orchard, Boise, ID 83705.—(By Lynn Yarris, SEA, Oakland, Calif.)

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Terry B. Kinney— Answers Questions

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Energy

- Development and use of alternative energy sources such as solar, wind, agricultural crops and residues, wood, geothermal and waste heat.
- Energy conservation in production, processing, and marketing.

Q: James L. McNaughton Animal Scientist, Mississippi State University, Starkville, Miss., and

Gustave D. Thomas, Biological Control of Insects Laboratory, Columbia, Mo., and

J. van Schilfgaarde, Director, U.S. Salinity Laboratory, Riverside, Calif.:

The future of SEA-AR depends upon a cadre of well-qualified, dedicated scientists. We are seeing a gradual decline in the number of young scientists entering agricultural research. What do you see as possible methods for reversing this trend?

A: Dr. Kinney: This is an overall agency concern—we must indeed reverse the trend. The regional and area staffs are trying to develop a balance of experienced, mature scientists and young, recent graduates in each of the investigation groups and laboratories. We are also expanding as rapidly as possible our research associate program, which in 1980 brought 20 young scientists with advanced degrees on board. This program will help to make the students and staffs of educational institutions aware of the career opportunities in SEA-AR.

Some of our larger research units are also providing opportunities for students to conduct their graduate work in SEA-AR facilities, thus helping to infuse new ideas and technology into our present research programs.

The Regional Administrators and I have agreed to address this problem head on. It is part of the larger problem of maintaining scientific excellence. It has been accepted by each of us as one of the elements on which our performance will be judged in 1981 and ensuing years.

Q: Truman L. Ward, Physicist, Southern Regional Research Center (SRRC), New Orleans, La.:

In developing human resources, SEA training appears to be aimed almost exclusively at supervisory or management training programs. What is the agency doing to increase in-house and other science training to keep research personnel up-to-date on new technology and knowledge?

A: Dr. Kinney: It is the responsibility of our research leaders to constantly assess and respond to the needs of scientists and technicians for the training necessary to perform their research responsibilities. Generally scientific or technical training can be provided more effectively by outside institutions, while management training is more easily accessible in-house, thus the apparent imbalance. Technical training should be tailored to the needs of individual scientists. Therefore, it is necessary for the scientist, in consultation with his or her supervisor, to develop an individual plan for formal training. Supplemental on-the-job training can also be arranged by allowing our scientists and technicians to spend necessary time at SEA-AR laboratories.

Q: Antoinette A. Betschart, Nutrients and Food Technologist, Western Regional Research Center (WRRC), Berkeley, Calif.:

A dynamic and progressive program in agricultural research is essential to maintain and expand the international leadership of U.S. agriculture. What methods do you envision as necessary to encourage public and descision-maker support to this end?

A: Dr. Kinney: In agricultural research, we are often ultraconservative. Most of us have felt that if we conduct and publish outstanding research we will be recognized—and we have been—by our colleagues. We have not done a

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Terry B. Kinney— Answers Questions

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good job of informing the general public about our accomplishments.

If you ask a scientist for an interpretive summary of a published research project, you usually get slightly modified "scientific jargon" summarizing the abstract. What happens then? Someone less knowledgeable translates the research results into layman's language — often with misinterpretation — if it is translated at all. We need to work much more closely with information specialists who can help translate our research results to speed their adoption and to increase the public's understanding of what we do. We must do a better job of cooperating with information specialists; they can work with us to target the information to the right audiences at the right time. It is the most powerful mechanism we as a research organization have to inform the public and decisionmakers.

Q: Ronald Fayer, Ruminant Nutrition Laboratory, Animal Parasitology Inst., Beltsville, Md.:

In a recent article written by Nicholas Wade in **Science** *magazine, the Nobel Laureate economist Milton Friedman was quoted as saying that he would do away with government support of research and higher education, and challenged anyone to find a single study justifying the amount of money now being spent on government support of research.*

A: Dr. Kinney: Milton Friedman's suggestion that all government research funding be terminated would be an interesting experiment, the most dangerous ever undertaken — barring none. The study he challenges us to find does exist — at least for American agriculture. Today the United States is the major agricultural resource for much of the world's food and technology because of the strong cooperative base of research among federal research programs, universities and the land-grant college system, and industry. However, industry rarely invests in long shots, and our basic research is often that.

Q: William M. Doane, Northern Regional Research Center (NRRC), Peoria, Ill.:

What role do you see for SEA-AR during the next decade in helping the Nation meet fuel and petrochemical needs by using farm-grown raw materials?

A: Dr. Kinney: Continued rise of oil prices will increase the pressures for accelerating U. S. production of alternatives to oil-based fuels. As the agricultural research arm of the federal government, we can effectively research the development of improved crops to produce fuel. SEA-AR will also continue research on how crop residues might contribute to the national energy supply without unduly depleting organic material resources necessary for soil protection and crop production.

Policy decisions will determine exactly what energy research will have priority.

Q: Timothy A. Calamari, Research Chemist, Southern Regional Research Center (SRRC):

Is there any way in which pending redirection of SEA-AR research could be slanted to ensure that the regional centers are brought more into the mainstream and become more involved in high priority work? Or, put another way – what future do you see for the regional research centers?

A: Dr. Kinney: I consider the four regional research centers unique SEA-AR assets, providing a combination of basic research and applied research technologies. Because of the mixture of disciplines among their staffs and their often unique facilities and equipment, these centers will continue to make important contributions to present and future research priorities of the agency. There has been substantial redirection in these areas. Examples include marked increases for research in pollution, water quality, food preservation, integrated pest management, and nitrogen fixation.